Offshore Renewable Energy in Virginia

Presented to the Renewable Natural Resources Foundation

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Virginia Coastal Energy Research Consortium (VCERC)

5 Government, 3 Industry, and 8 Universities

Created by the Virginia legislature in 2007 to provide the research and development necessary for the commercialization and implementation of renewable energy by using the state's wind and wave resources.

Governed by a board consisting of representatives from eight partner universities and six government and industry partners.

Driven by Department of Energy's energy-independence strategy.

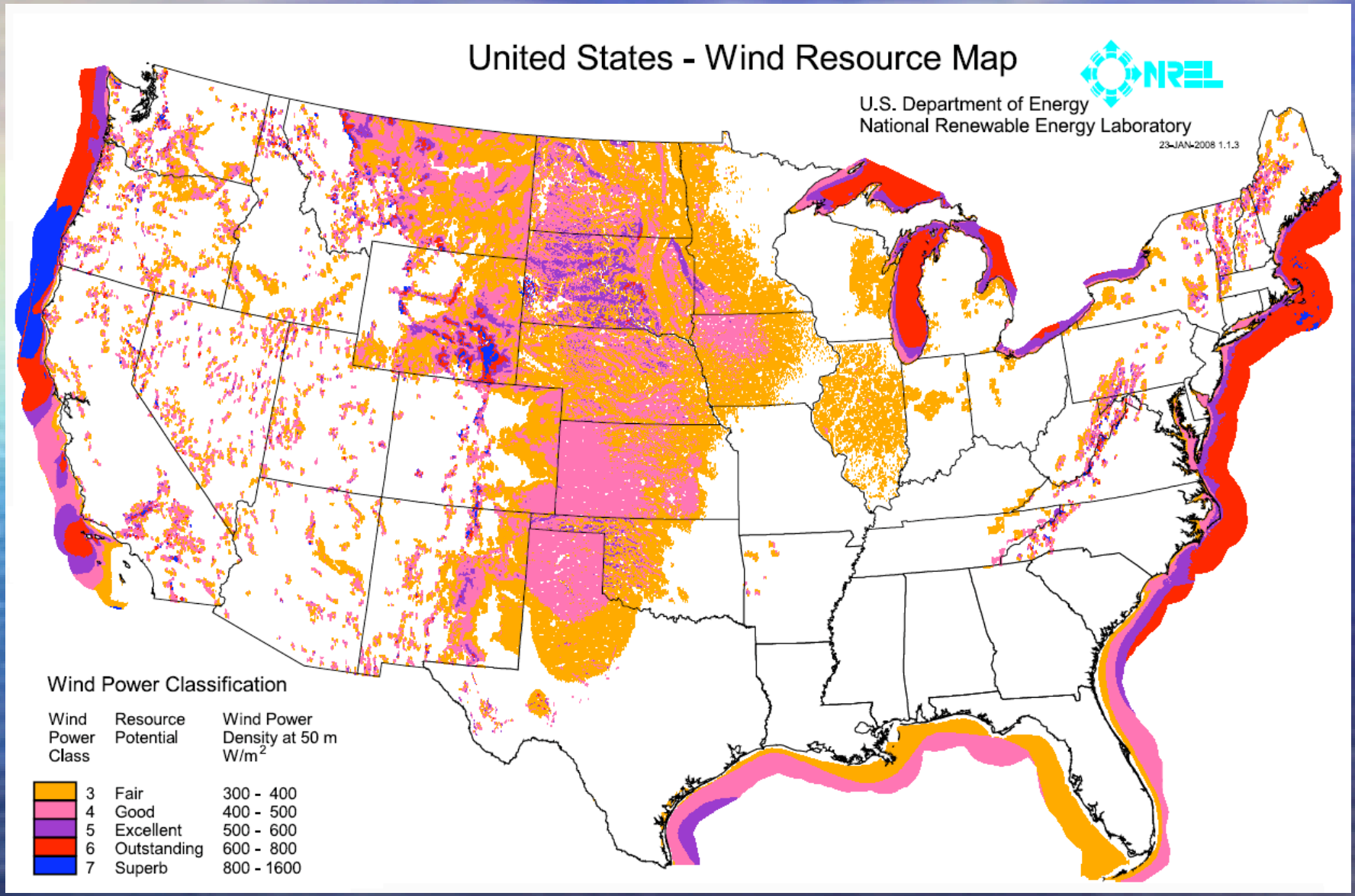
Research thus far has been primarily aimed at offshore wind, wave, and tidal energy in Virginia Beach.

HAMPTON ROADS TECHNOLOGY COUNCIL

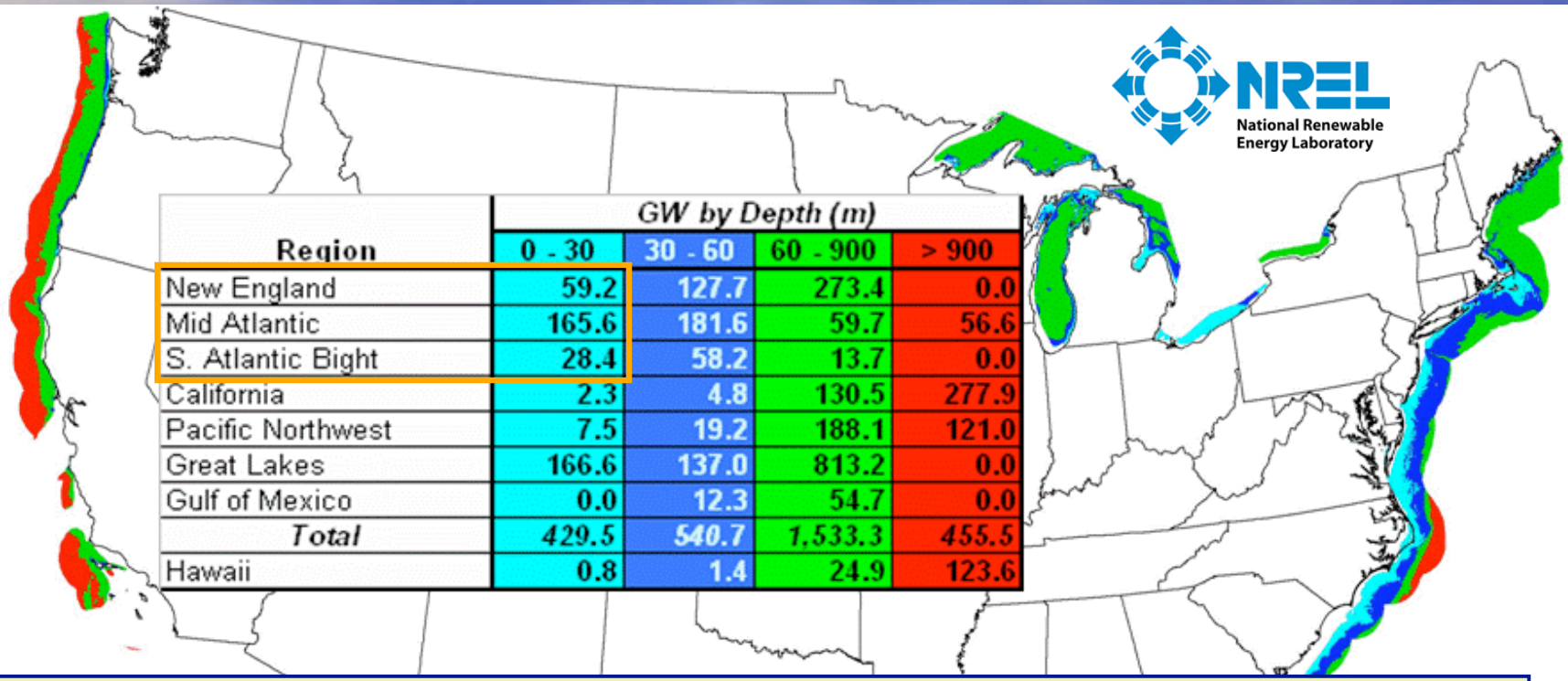
U.S. Population in Atlantic, Pacific, Gulf of Mexico and Great Lakes States

Twenty-eight coastal states in contiguous U.S. are home to 58% of population and account for 78% of total U.S. electricity demand.

U.S. Wind Resources



U.S. Wind Energy Potential Between 5 - 50 Miles Offshore

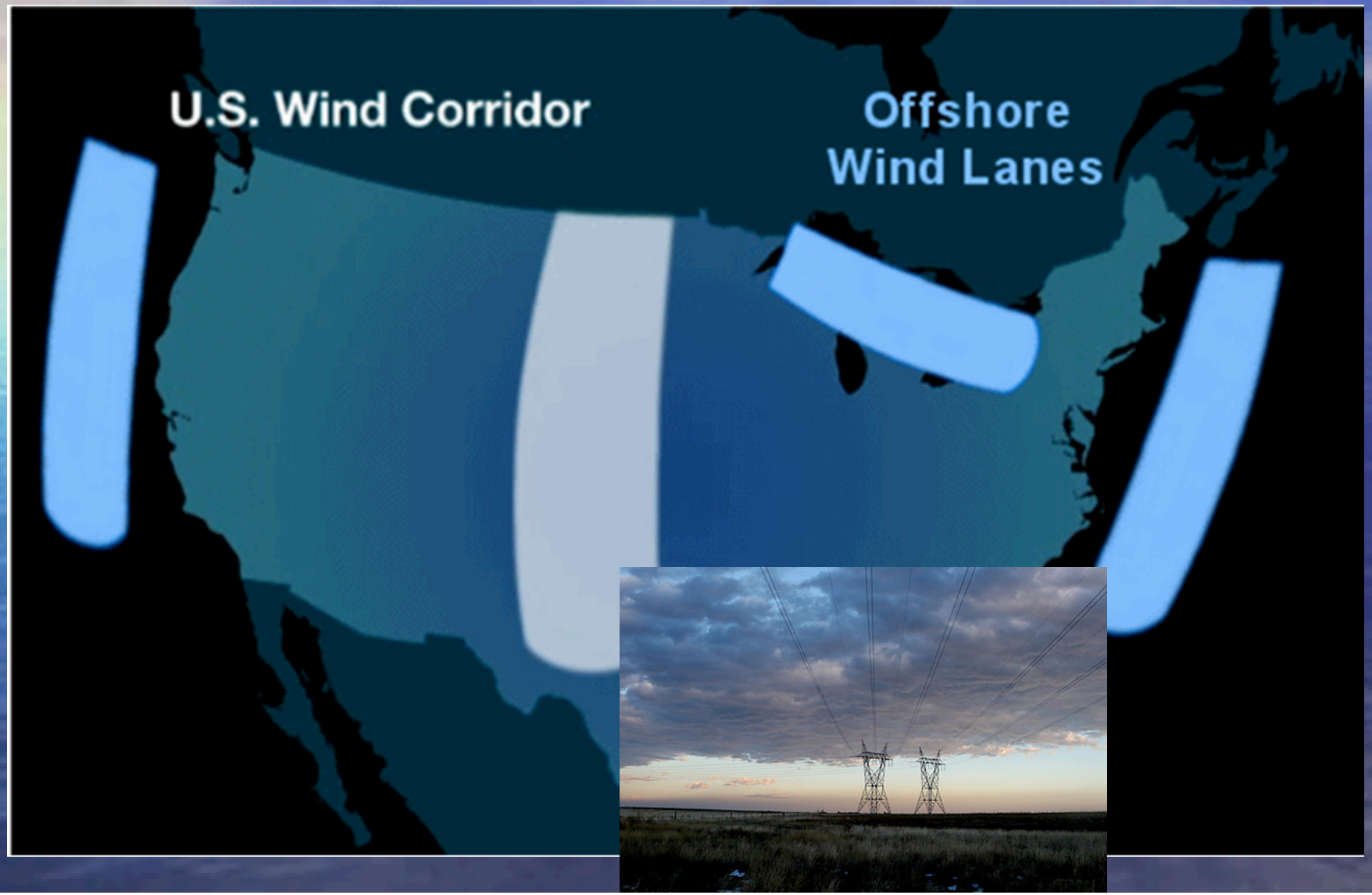


Region	GW by Depth (m)			
	0 - 30	30 - 60	60 - 900	> 900
New England	59.2	127.7	273.4	0.0
Mid Atlantic	165.6	181.6	59.7	56.6
S. Atlantic Bight	28.4	58.2	13.7	0.0
California	2.3	4.8	130.5	277.9
Pacific Northwest	7.5	19.2	188.1	121.0
Great Lakes	166.6	137.0	813.2	0.0
Gulf of Mexico	0.0	12.3	54.7	0.0
Total	*429.5*	*540.7*	*1,533.3*	*455.5*
Hawaii	0.8	1.4	24.9	123.6

Total potential installed offshore Atlantic OCS wind capacity in water depths <30 m is 253.2 GW. At an annual average capacity factor of 35%, total annual electrical energy production would be 776,300 GWh. With a gas-fired power plant heat rate of 8.0 BCF per GWh, the equivalent natural gas usage that could be displaced by Atlantic OCS shallow-water offshore wind is ~6,210,000 BCF per year. Only a fraction of this total wind potential can be developed, due to other ocean uses and environmental concerns.

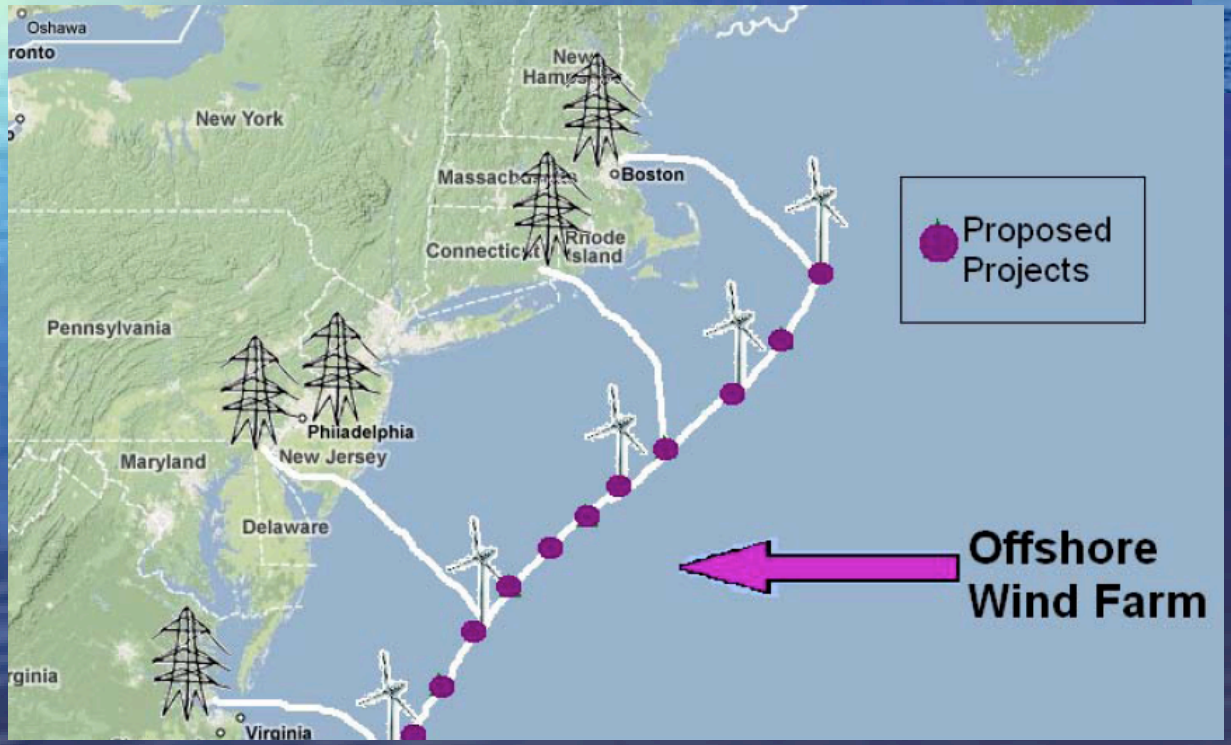
Energy Transport

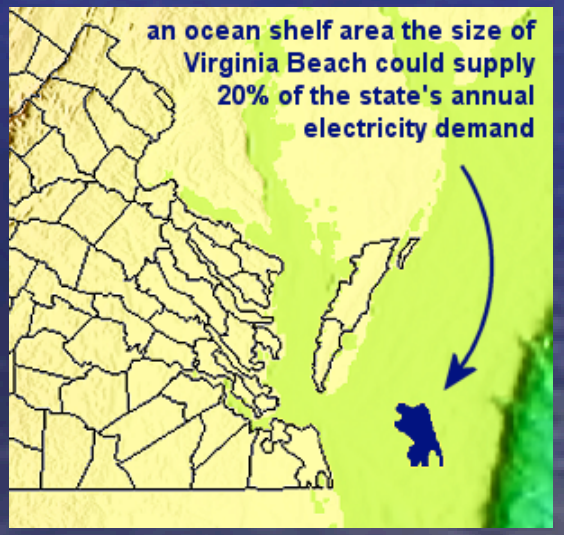
Should we rely on robust East-West transmission cables, or direct regional resource utilization?



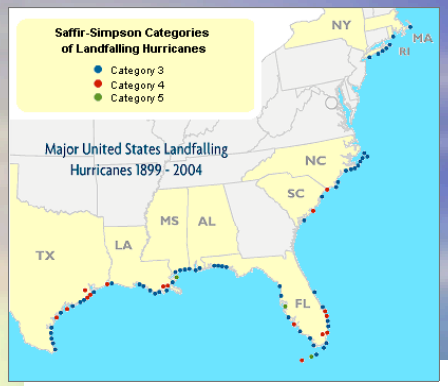
Wind Energy

A Vision



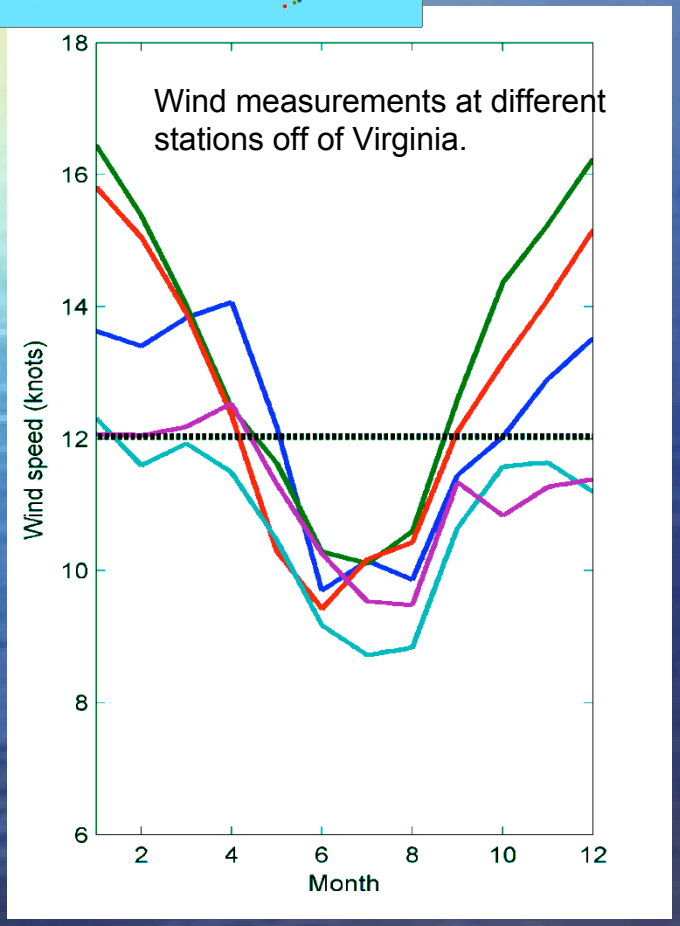


Regional Resources



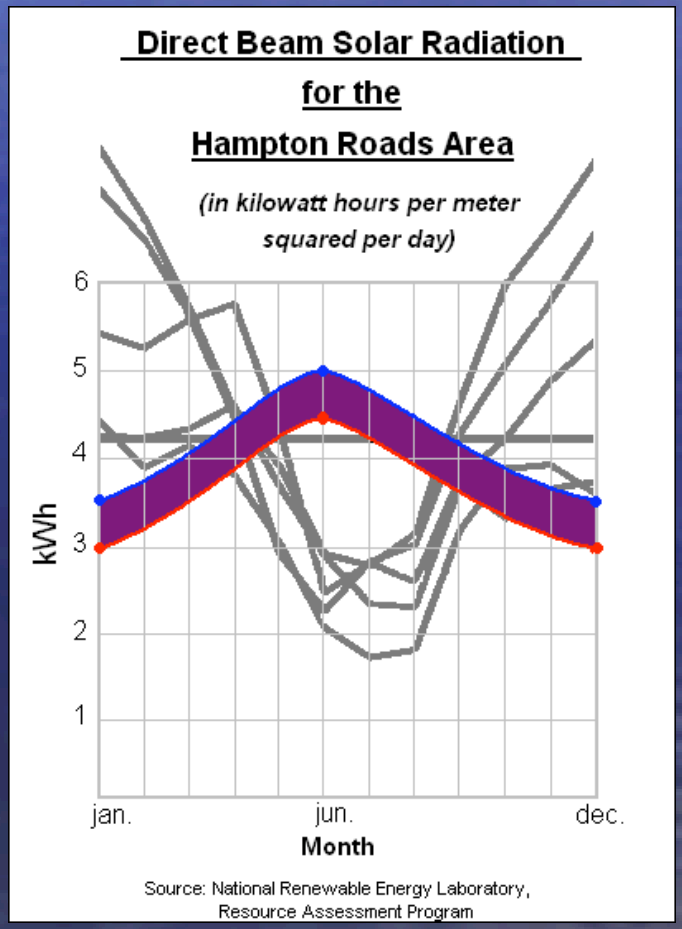
Wind speeds of 6 m/s or higher, average of 7.1 m/s, 0.78% calms.

Low hurricane impact.

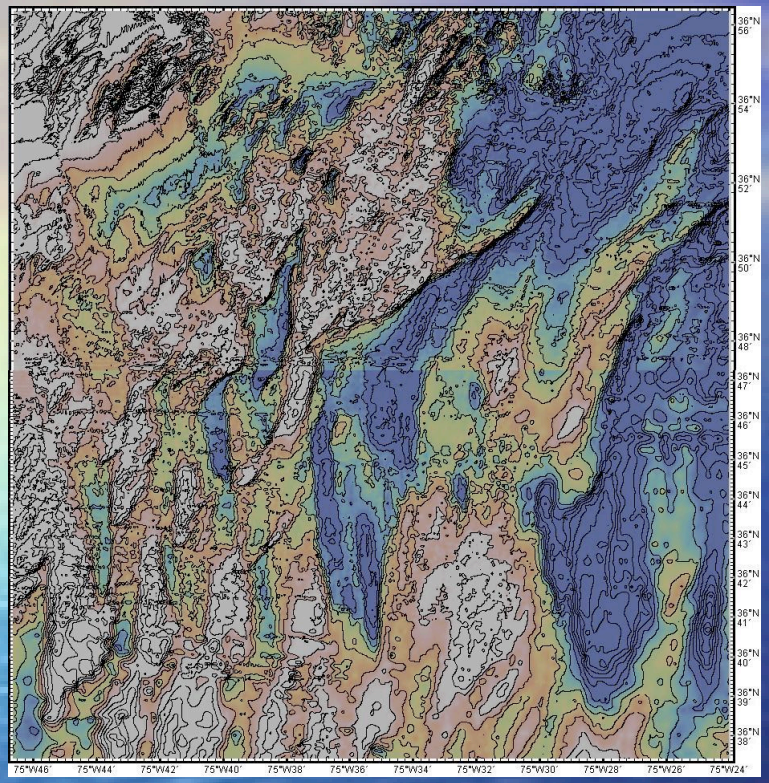


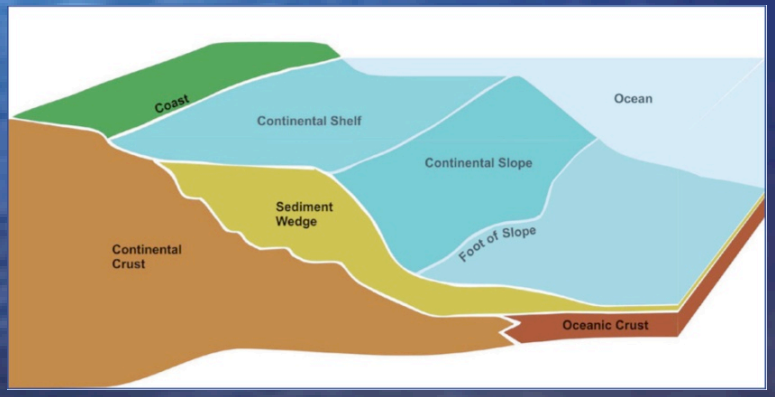
Wind density increases with distance from shore.

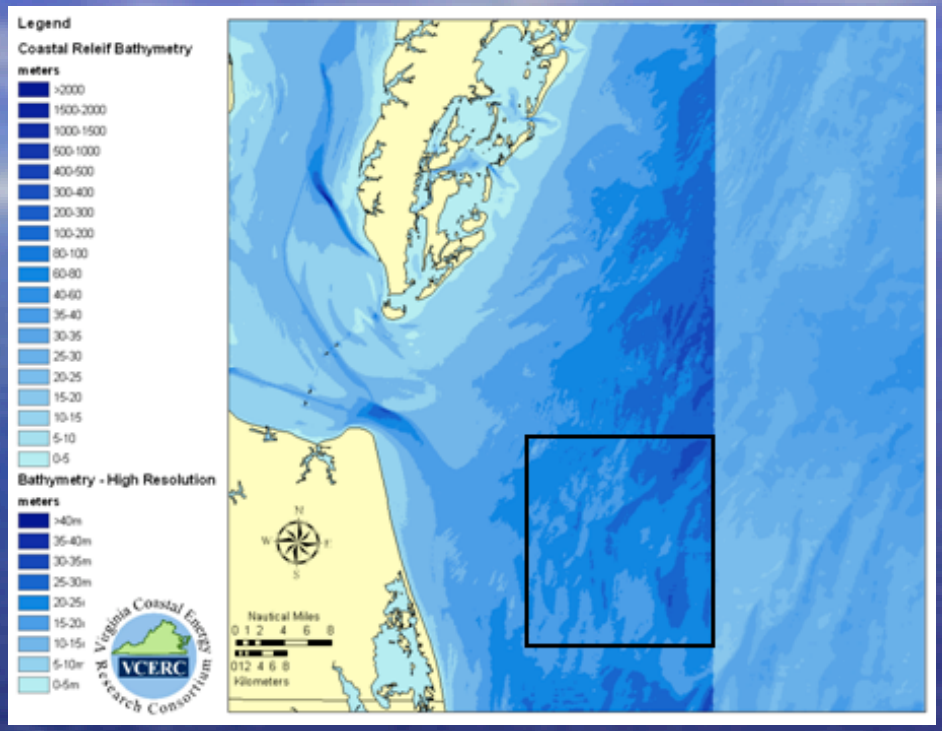
Solar energy has potential to compensate for coastal energy during periods of low wind velocities.



Offshore Geophysical Conditions







Average depth of 30 meters.

Access to shallow depths farther out to sea.

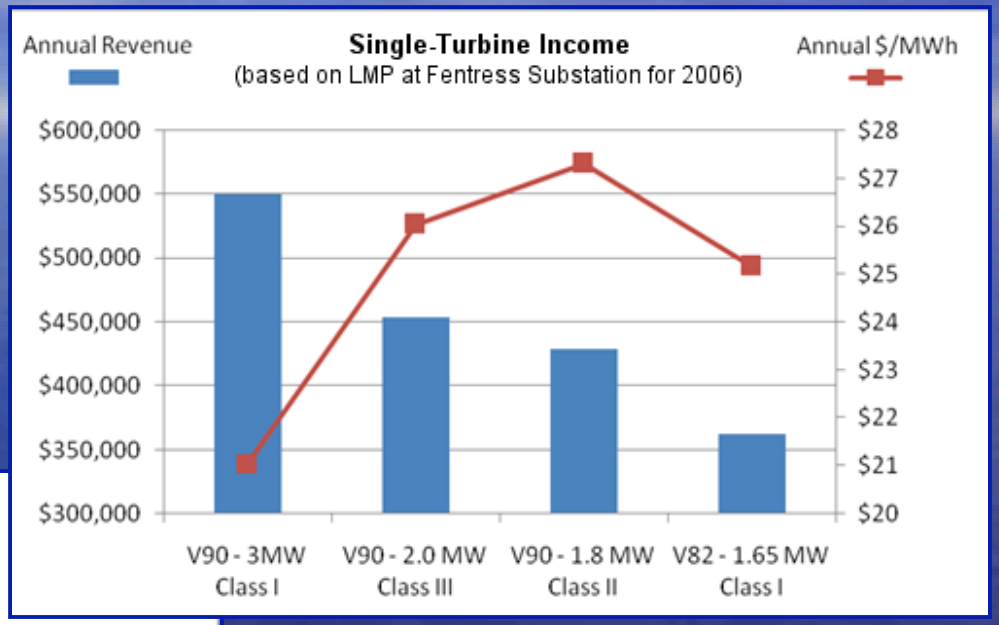
Bottom covered by coarse sediments:

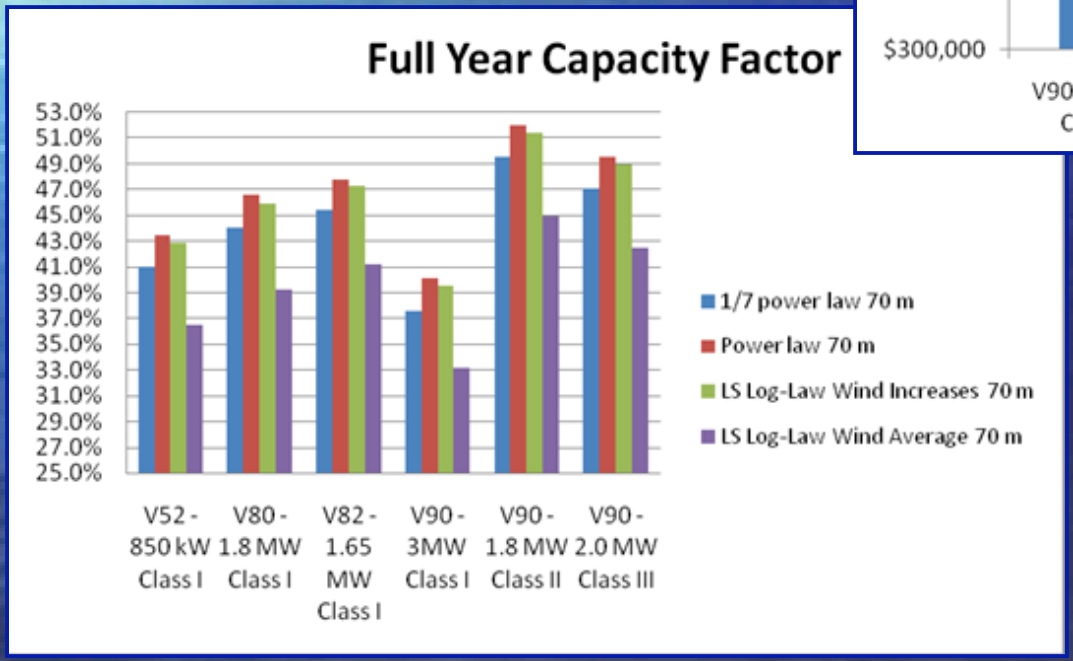
- **Sand (90 - 97%)**
- **Mud (3 - 9%)**
- **Clay (1 - 2%)**

Offshore Wind Turbine Performance

Data Collected by ODU, Evaluation Performed by Virginia Tech

Virginia's offshore winds are lower than those in the North Sea, such that smaller generators with larger rotor swept areas perform better than the 90-meter, 3-megawatt Vestas turbine commonly used in European projects.





For wind turbines appropriately sized for Virginia's offshore wind project, annual average capacity factors are in the range of 40-50%, which is much higher than typical land-based wind turbines in the Mid-Atlantic region, which have annual capacity factors of 30-35%.

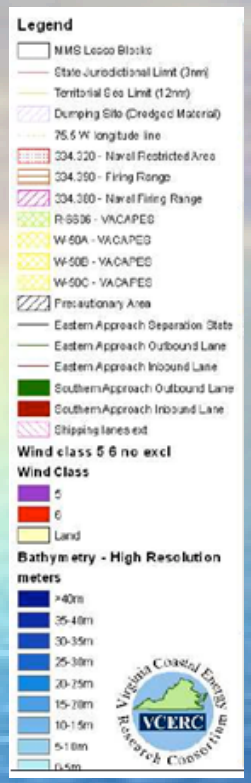
Research and Development Incentives

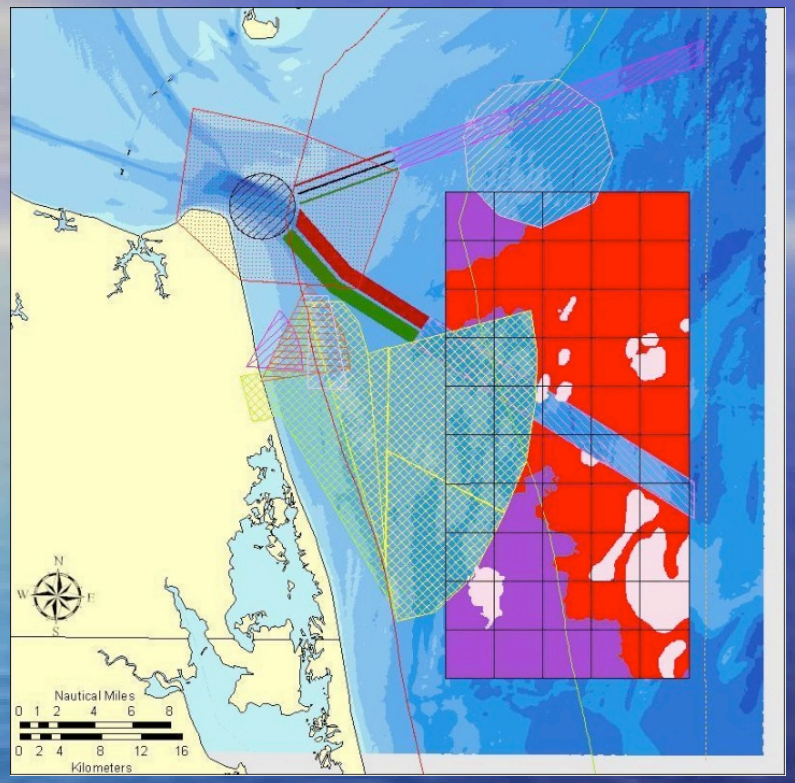
The U.S. DOE initiated a Waterpower R&D Program in FY 2008 with a Congressionally mandated $10 million. The Senate and House mark up appropriation bills for FY 2009 were between $30 and $40 million.

Electric Power Research Institute confirms that US has access to adequate resources to support the serious investigation of adding marine and hydrokinetic technology to America's national energy portfolio.

In a December 2008 report, EPRI recommends immediate modeling and field testing to investigate energy potential, cost, environmental impact, and energy storage possibilities; as soon as funding is available

Virginia Offshore Maritime Activity



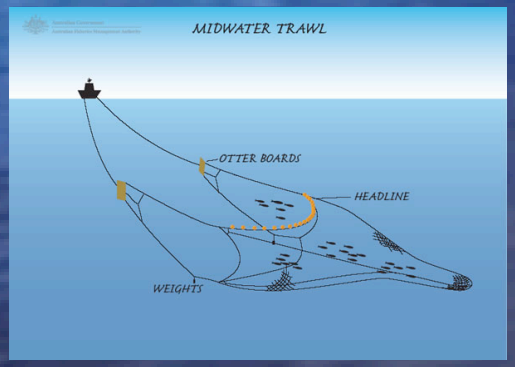


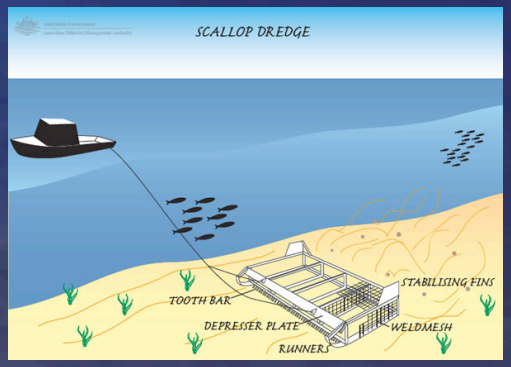
Cooperation and consideration for both existing and future ocean users.

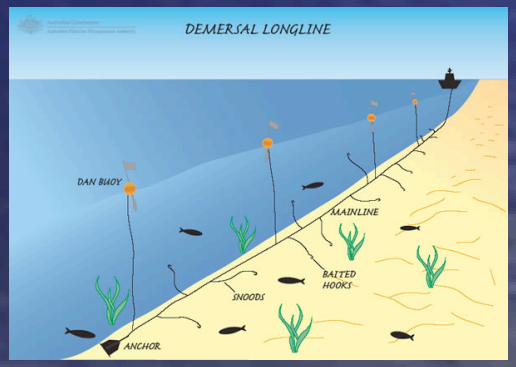
Mapping of shipping, Naval, and fishing activity near possible wind turbine sites.

MMS lease blocks are 4.8 x 4.8 km, each having 7 x 7 turbines.

Primary fishing gear used offshore:







Maritime Spatial Planning

UNESCO has formed a MSP Initiative with the goal of helping countries organize ecosystem-based management of their offshore resources.

Step-By-Step Approach:

Create and establish a more rational use of marine space and interaction between its users.

Achieve social and economic objectives in an opened and planned way.

MSP *is not* enforced law or a substitute for single-sector management.

MSP *is* a guide towards beneficial cooperation across different sectors by addressing the cumulative effects of multiple human uses of the same marine space.

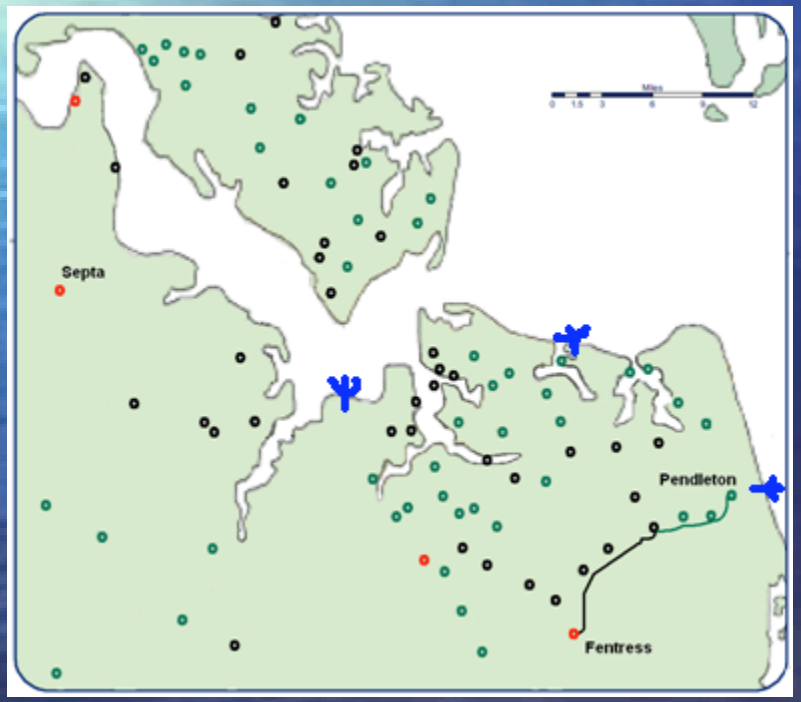
UNESCO

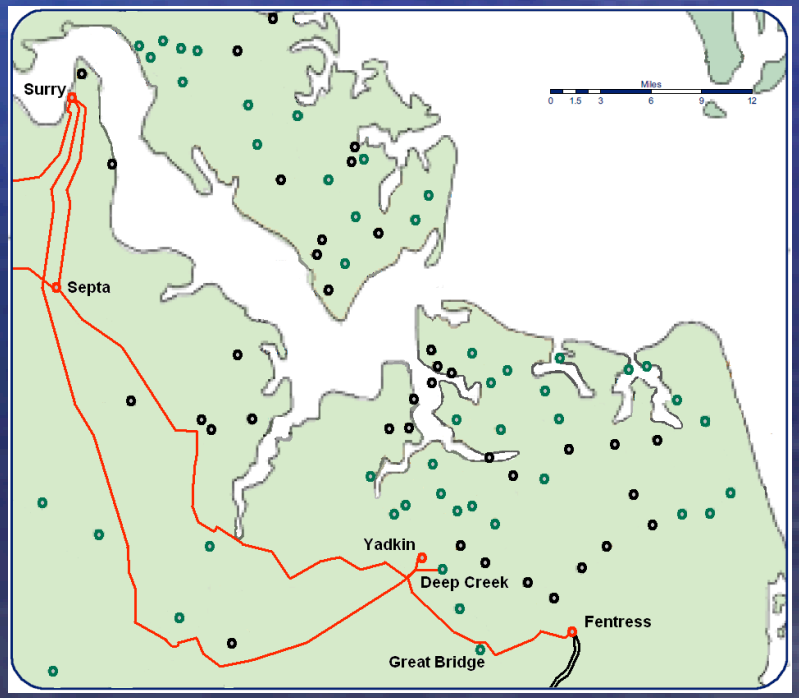
Incoming Cables

Primary plan is to bring in cables at Virginia Beach, from between 13 and 24 miles offshore.

Backup plan would require going through bay, roughly 40 miles.

The Pendleton substation lies about 2.5 miles inland from the shore. The cable line from Pendleton travels a little over six miles on a 115 kV line to the Landstown substation, where it ties into a 230 kV line to Fentress.





Birds And Turbines

Atlantic City, NJ – Five wind turbines put online at a sewage treatment plant in December, 2005.

New Jersey Audubon Society conducted a study that found 30 birds deaths related to the Atlantic City turbines over an 18 month period.

Portsmouth Abbey in Rhode Island constructed a single turbine in March, 2006.

Turbine has only seen one bird fatality, a red-tail hawk in Spring, 2008. No incidents with bats or other animals.

President of the Audubon Society, John Flicker, still ultimately supports wind, saying you can't even count the number of bird carcasses from the pollution from coal and gas burning furnaces, so letting those continue to be our main sources of energy is much worse for birds than turbines.

Environmental Benefits

Provides artificial reefs.

Creates habitat for fish and other marine animals.

Increases fish productivity.

Fish densities can be 20 to 50 times higher.

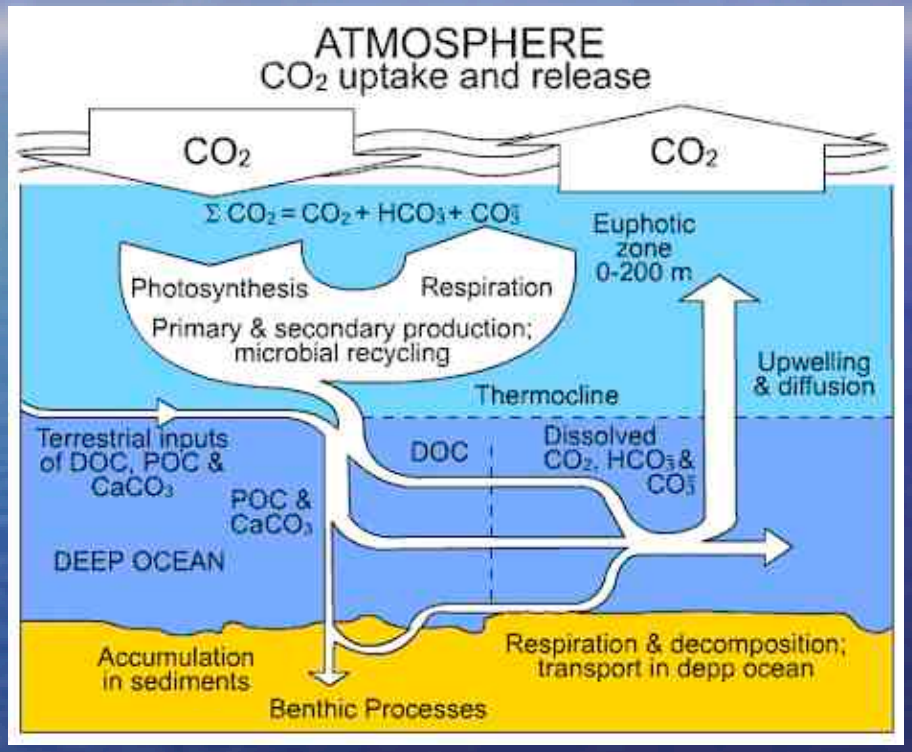
Recreational fishing.

Recreational diving.

VCERC can provide preliminary impact analyses to optimize offshore development.

Oceanic Acidification

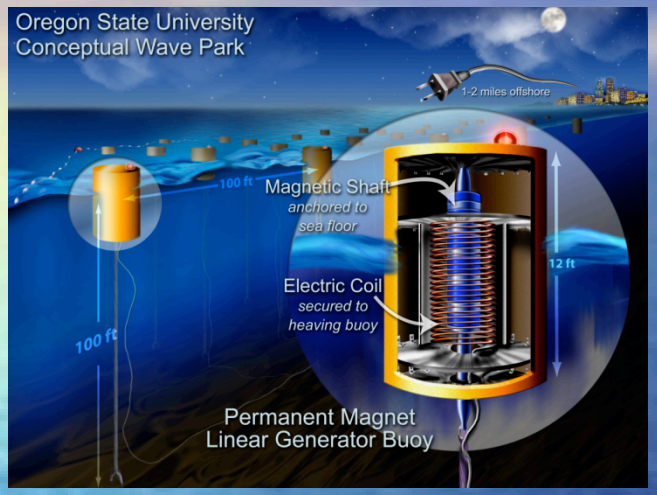
Studies are beginning to indicate that as the ocean absorbs carbon in the air, it becomes more acidic and thus less reactive to continue to absorb carbon.



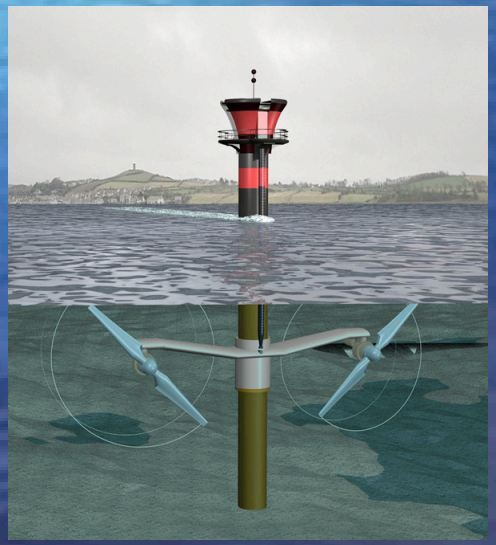
November, 2009, Columbia University study took measurements of seawater samples from the past 20 years.

As human-generated emissions of CO_2 increase, the oceans' uptake rate has slowed by about 10% between 2000-2007.

Integrated Energy Solutions
(wind - wave - tidal)

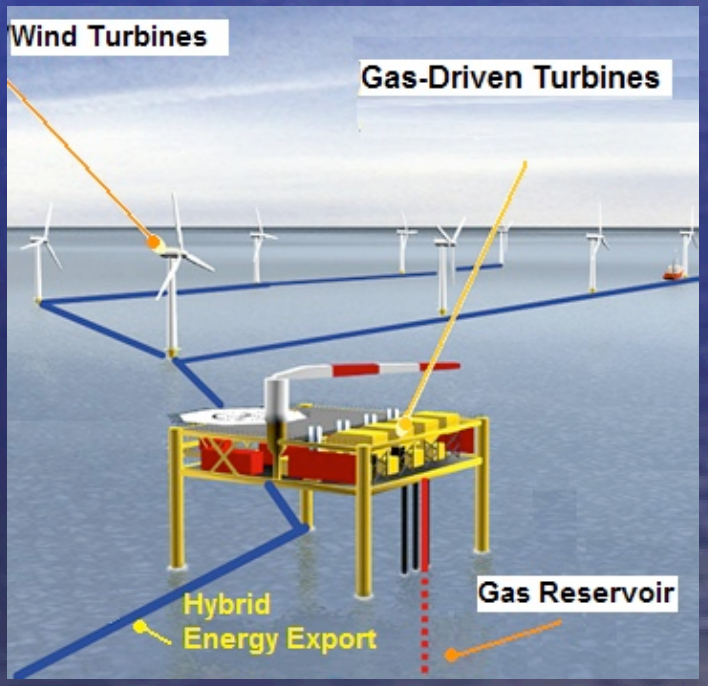


Wave buoys utilize vertical wave motion to generate electricity.



Ocean current devices driven by flowing water rather than air. Can generate electricity from tidal currents, ocean currents, or river stream currents.

Wind-Gas hybrid possibilities for accessing natural gas deposits at sea.



Summary

Assess integrated technologies.

Obtain more physical environment site data.

Modeling and Simulation.

Assess device performances in situ.

Ocean Response:

- Habitats
- Acidification
- Cumulative Effects

Additional Questions?